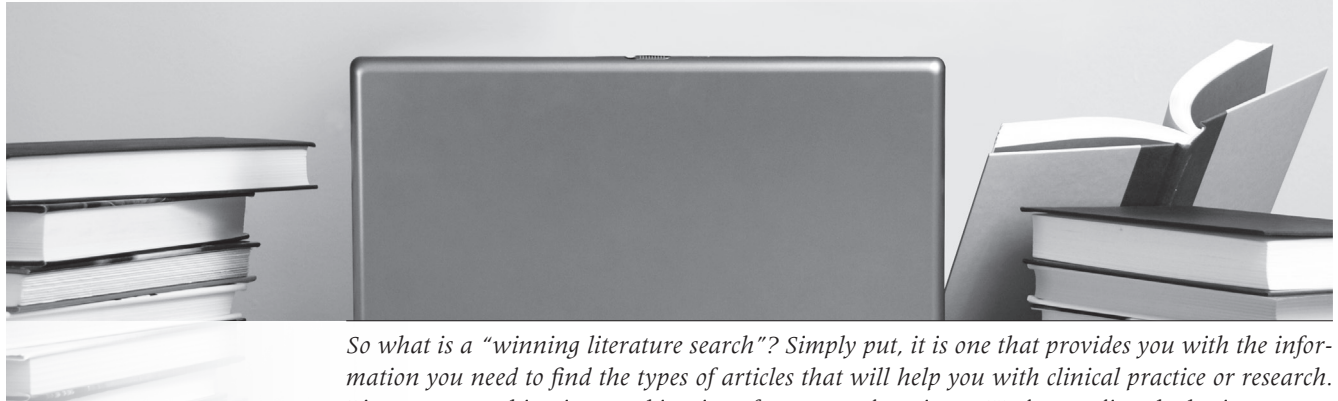# Conducting a winning literature search

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So what is a "winning literature search"? Simply put, it is one that provides you with the information you need to find the types of articles that will help you with clinical practice or research. Literature searching is a combination of an art and a science. Understanding the basic anatomy and physiology of searching can get you started on finding the information you need.

I. ANATOMY OF A LITERATURE SEARCH—THE SKELETON

A. Constructing an appropriate question

- Asking the right question is the primary key to creating a winning search. Your questions must be answerable. If your question is too broad, your search will yield more information than you can possibly look through.
- Suppose you are interested in determining the incidence of commonly reported complications following artificial disc replacement (ADR) as compared with fusion.

Too broad	More answerable	Better yet
What is the incidence of complications following ADR versus fusion?	What is the incidence of complications following ADR versus fusion of the *lumbar spine?*	What is the incidence of complications following ADR versus fusion for *degenerative disc disease* of the lumbar spine? Or even… What is the incidence of complications following *single-level* ADR versus *single-level* fusion for degenerative disc disease of the lumbar spine?

PICO (Patients, Intervention, Comparator, Outcomes) table for designing your question

	Included	Excluded
Patients	Degenerative disc disease at one level of the lumbar spine	All other diagnoses (ie, tumor, trauma); 2- or 3-level disc disease; cervical disease
Intervention	Artificial disc replacement	
Comparator	Fusion	
Outcome	Death, infection, subsidence and migration, loss of disc height, heterotopic ossification and spontaneous fusion, reoperation	All other complications

Similarly, if your study was prognostic rather than therapeutic, a PPO table would be used instead of the PICO table in order to help formulate your question. Thus, the categories would change to Patients, Prognostic factors, and Outcome.

B. Using the appropriate database(s)

Now that you have honed your question, it is time to focus on efficient article retrieval. What type of information is needed and what type of articles do you need? What will you do with the information you gather? This will determine the type of information you need and types of articles that may provide that information. It also may influence the type of database you search for that information.

- Bibliographic databases contain references to published literature, such as journals and newspaper articles, conference proceedings and papers, reports, government and legal publications, patents, and books.
- Two types of literature that are often the focus of systematic searches are indexed, peer-reviewed literature, and gray literature.
  - Peer-reviewed literature is scholarly work that generally represents the latest original research in a field. These articles undergo expert screening before publication to ensure meaningfulness within the context of other research in the discipline and, at least in theory, sound methodology.
  - "Gray" literature refers to material that is not formally published by commercial publishers or peer-reviewed journals, including reports, fact sheets, white papers, conference proceedings, and other documents from various organizations and government agencies.

The table below provides brief descriptions of common databases and sources to search both peer-reviewed and gray literature.

Database & website	Description	What is included
Indexed, peer-reviewed literature		
MEDLINE http://www.ncbi.nlm.nih.gov/pubmed/	– National Library of Medicine's (NLM) premier bibliographic database – PubMed is a free search engine and is maintained by the National Center for Biotechnology Information (NCBI) at the NLM – Contains over 19 million citations	– Academic journals covering the fields of medicine, nursing, dentistry, veterinary medicine, the health care system, preclinical sciences – Much of the literature in biology, biochemistry, molecular evolution – International in scope
EMBASE (Excerpta Medica Database) http://www.embase.com/	– Comprehensive biomedical and pharmacological database – Maintained by Elsevier and can be accessed by subscribed users only – Contains over 20 million citations	– Active, peer-reviewed journals – Broad international scope

Database & website	Description	What is included
Cochrane Reviews http://www.cochrane.org/reviews/	– Database comprised of formal, extensive systematic reviews that often contain meta-analysis – Maintained by The Cochrane Collaboration, an international nonprofit organization, and published and hosted by Wiley InterScience – Offers free access to abstracts and some full length articles; however, most full text reviews require a subscription or pay-per-view access – Designed to facilitate clinical decision-making in healthcare by exploring the evidence for and against the effectiveness and appropriateness of treatments in specific circumstances	– Topics including medications, surgery, technology, education – Articles are also indexed in PubMed
Cochrane CENTRAL (The Cochrane Central Register of Controlled Trials) http://uscc.cochrane.org/en/newPage3.html	– Collection of databases in medicine and other healthcare specialties – Uses a search interface called OVID	– Focuses on randomized or controlled research articles
AOSpine−EBSS.live http://www.aospine.org/	– Comprehensive database designed to streamline the search process by providing evidence on treatment of spine problems that is organized effectively and graded according to evidence class – Maintained by AOSpine International and requires a paid membership for access	– Summaries of recently published research articles on a variety of topics, including spine therapies, prognoses, and diagnoses
Gray literature		
AHRQ (Agency for Healthcare Research and Quality) http://www.ahrq.gov/	– Lead federal agency charged with improving the quality, safety, efficiency, and effectiveness of health care for the United States – Established twelve evidence-based practice centers (EPCs) that develop evidence reports and HTAs on topics relevant to healthcare organization and delivery issues, specifically those common to and/or significant for the Medicare and Medicaid populations – Maintained by AHRQ staff and provides free, online access	– Focuses on synthesizing the evidence and facilitating the translation of evidence-based research.
NCG (National Clearinghouse Guidelines) http://www.guideline.gov/	– Free, public resource for evidence-based clinical practice guidelines – Created and maintained by the AHRQ	– Evidence-base for guidelines is described – Syntheses of selected guidelines that cover similar topic areas – Expert commentary on issues of interest and importance to the clinical guideline community
INAHTA (International Network of Agencies for Health Technology Assessment) http://www.inahta.org/HTA/Database/	– Database containing information on HTAs from various countries around the world – Managed by INAHTA Secretariat in collaboration with their United Kingdom member Centre for Reviews and Dissemination (CRD) – Free access	– Research including systematic reviews, ongoing and completed trials, questionnaires, and economic evaluations

For example, continuing with our question regarding complications after ADR versus fusion, which type of database listed in the table makes the most sense to search? Indexed peer-reviewed articles will give us the best available and most current data and MEDLINE, which includes millions of citations for biomedical articles and can be accessed using PubMed for free, seems like a great starting place. Generally speaking, PubMed will be the best place to begin your search and there are various ways, as you will see below, to refine and limit your search in order to find exactly what you need.

II. THE PHYSIOLOGY OF LITERATURE SEARCHING—HOW IT WORKS

Now that you have an answerable question and an idea of what type of database you need to search (at least to start), let's talk about the nuts and bolts of searching. For the purposes of this paper, we will use PubMed as the search engine.

A. Getting specific—the basics of "how to"

1. Quickstart:
- Type a word or phrase into the query box, including subject, author, and/or journal
- Click on the search button or press the "enter" key
- Results will be displayed in summary format:

> Anterior fixation of odontoid fractures in an elderly population.
> Dailey AT, Hart D, Finn MA, Schmidt MH, Apfelbaum RI.
> J Neurosurg Spine. 2010 Jan; 12(1):1-8.
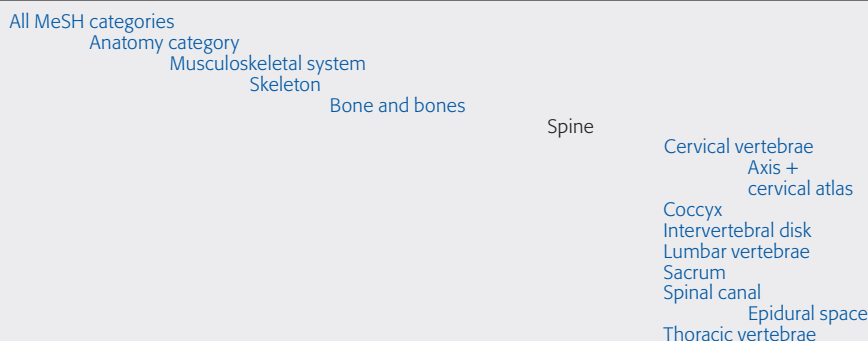> PMID: 20043755 [PubMed - indexed for MEDLINE]
> Related articles

- To retrieve more information about the search results, use the display settings menu (upper left corner) to view the abstract or MEDLINE formats, change the number of items that appear per page, and sort by recently added, publication date, first author, last author, journal, or title.
- PubMed also contains links to full-text articles (appears in upper right corner of page) at participation publishers' web sites as well as links to other third party sites such as libraries and sequencing centers.

2. Advanced searching in PubMed—MeSH terms and the MeSH database:
a. Medical subject headings (MeSH)

It is important to understand that PubMed uses a controlled vocabulary to index journal articles called MeSH and uses "automatic term mapping" to find MeSH terms when you search. MeSH terms are organized in a hierarchy called a tree, with more specific (narrower) terms arranged beneath broader terms. By default, PubMed includes in the search all narrower terms; this is called "exploding" the MeSH term. Inclusion of MeSH terms enhances and optimizes the search strategy. For example, if you looked up the term "Spine" in the MeSH database you would see:

> All MeSH categories
>   Anatomy category
>   Musculoskeletal system
>   Skeleton
>   Bone and bones
>   Spine
>   Cervical vertebrae
>   Axis +
>   cervical atlas
>   Coccyx
>   Intervertebral disk
>   Lumbar vertebrae
>   Sacrum
>   Spinal canal
>   Epidural space
>   Thoracic vertebrae

Therefore, PubMed would retrieve every article containing any of the terms located under Spine in the hierarchy.

b. MeSH database features

MeSH vocabulary contains over 25,000 descriptors and is updated weekly and reviewed annually. You can only search citations that have been indexed for

⇨ Anything which appears in blue and is underlined is a link that reveals more information. Clicking on the title would bring up the abstract (Abstract format). Clicking on "Related articles" would provide a link to other similar articles that might be of interest.

MEDLINE (92% of the PubMed database) using MeSH terms. Features include:

- Allows you to identify and select appropriate MeSH terms for a search and to see their definitions
- Builds a PubMed search strategy
- Displays MeSH terms in the hierarchy (MeSH tree) allowing you to broaden/narrow a search
- Limits MeSH terms to a major concept/topic heading for a search
- Allows you to broaden your search by choosing not to explode a term
- Attaches subheadings for a search creating complex search strategies
  - The list of subheadings includes terms paired at least once with a given heading in MEDLINE.
- Focuses searches using other types of MeSH terms including publication types [pt], substance names [nm] or registry numbers [rn], and pharmaceutical actions [pa]
- MeSH Brower for access to annotations: http://www.nlm.nih.gov/mesh/

To access MeSH from PubMed, click on MeSH Database on the PubMed homepage or click MeSH under "more resources" in "advanced search."

Once in the MeSH database, if you entered cancer into the search bar and clicked Go (or hit Enter) you would see:

€ 1: Neoplasms Links
    New abnormal growth of tissue….

Clicking on "neoplasms" will bring up the page where you have the option of selecting any of the features listed above to help you refine your search.

Also, clicking "links" adjacent to the MeSH term desired, will give you a drop-down menu which offers several options:

- PubMed: search PubMed with the term
- PubMed—Major topic: search PubMed with the MeSH term, retrieving only citations where the term is a major focus
- Clinical queries: put the MeSH term into the Clinical Queries box where the search may be further refined
- NLM MeSH browser: show the MeSH browser descriptor data for this term including scope note, allowable qualifiers, and the MeSH tree

⇨ The Mesh database homepage includes three brief tutorials on how to search with the MeSH database, combine MeSH terms, and apply subheadings and other features of the MeSH database.

B. Too much information! Refining your search

- Replace general search terms with more specific terms (the MeSH database would be a great resource for this)
- Add terms or combine search terms with connector words: AND, OR, or NOT using upper case letters (called Boolean logic)
  - AND between terms returns only records that contain all of the search terms
  - OR between terms returns all records that contain any of the search terms
  - NOT between search terms returns only records that contain the first term and not the second
- Truncate terms. Place an asterisk (*) at the end of a string of characters to search for all terms that being with that string. PubMed searches the first 600 variations of a truncated term.
  - Example: mimic* will find all terms that begin with the letters m-i-m-i-c-; eg, mimic, mimics, mimicking

- Use a wildcard. Use a "?" to replace a letter or denote an extra letter where spelling or word variation is possible.
  – Example: behavio?r will find behaviour or behavior
- Use the "limit" option in PubMed to limit citations by age group, language, publication type, date, human studies, etc.
- Use the "advanced search" option to look up a term as it is indexed in PubMed
- Use the MeSH database features

Example:
Let's say we are interested in what the best surgical treatment is for osteoporotic spine fractures. Using some of the tips above, the chart below shows how a typical search might go:

Search term(s)	# citations
"Spinal fracture" [MeSH] OR vertebral compression fracture	16023
"Spinal Fracture" [MeSH] OR vertebral compression fracture AND "osteoporosis" [MeSH]	3718
"Spinal Fracture" [MeSH] OR vertebral compression fracture AND "osteoporosis" [MeSH] AND "surg*"	911
"Spinal Fracture" [MeSH] OR vertebral compression fracture AND " osteoporosis" [MeSH] AND "Surg*" **Limits**: only items with abstracts, humans, clinical trial, English, publication date from 1990–2010	54

By combining terms (using Boolean logic), truncating a term, and using the limits option we were able to narrow our search down from 16,023 articles to a more manageable and relevant 54 articles. The "details" tab in the PubMed search window shows the complete search expression (ie, query translation) employed by PubMed, similar to what is represented in the table above.

Summary checksheet

☐   Use PICO (or PPO) to come up with an answerable question
☐   Decide what type of literature you will need to search in order to adequately answer your question
☐   Decide which database is most practical to use to start your search
☐   Pick out key terms from your question to enter into the database's search box
☐   Refine your search as necessary by combining terms and/or using limiting options that the database provides

One of the best resources that PubMed provides for users new to the database is the online tutorials. They are brief but informative and because they are interactive you are guided step-by-step through each process. Perhaps consulting the online tutorials and the fact sheets on PubMed would be a next step for you. Give it a try! In fact, here is the link to the PubMed Tutorial homepage created by the National Library of Medicine: http://www.nlm.nih.gov/bsd/disted/pubmedtutorial/. Also, check-out the PubMed help page which contains a plethora of information regarding all aspects of PubMed: http://www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=helppubmed&part=pubmedhelp

III. CLOSING THOUGHTS

Remember, literature searching is a combination of an art and a science. It requires practice, intuition, and some trial and error. While there is a basic structure, a set of guidelines and many tools for assisting one with basic searches, there are a variety of nuances and advanced techniques that may be required for more specialized searches. For systematic reviews as an example, extensive searches are required and may take numerous hours, involving many databases (including those for gray literature), and a combination of advanced search strategies in order to be methodologically sound. Use of personnel with specialized expertise in conducting such searches may provide the best results and be the most resource effective.